H$_2$O-302

SC WaterWays

answering today's water resource challenges for future generations

An Introduction to Porous Pavement

Terasa Young, Water Resources Agent, Clemson Extension

May 2013

Porous pavement, or permeable pavement, is an engineered hardscaping surface that allows water to flow through it. This differs from traditional types of pavement, which are impermeable and convert most rainfall to runoff.

Types of porous pavement

There are three basic types of porous pavement, which are generally suitable as an alternative to the traditional impermeable surface:

1. Porous asphalt *(Fig. 1)*
2. Pervious concrete *(Fig. 2)*
3. Permeable interlocking concrete pavers (PICP) *(Fig.3)*

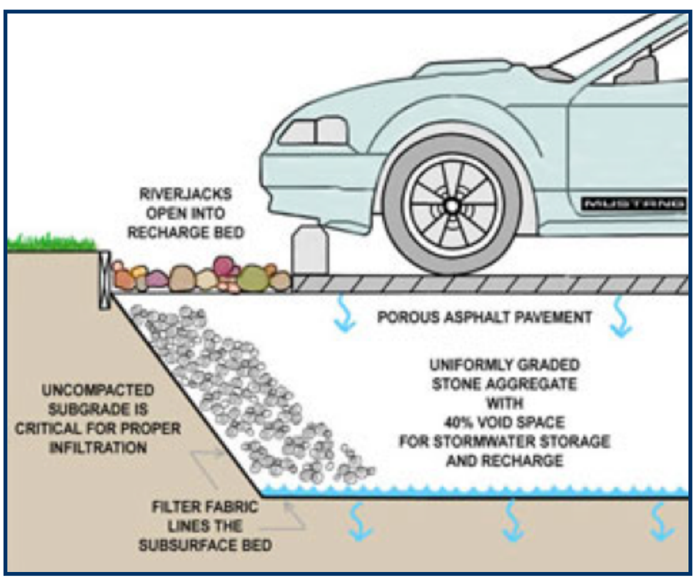

Fig. 1. Porous asphalt illustration.
http://www.wbdg.org/resources/lidtech.php
Credit Cahill Associates, Inc.

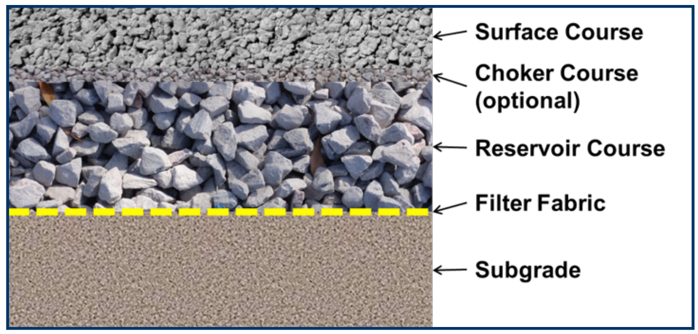

Fig. 2. Pervious concrete illustration. Credit Brad Putman, Ph.D.

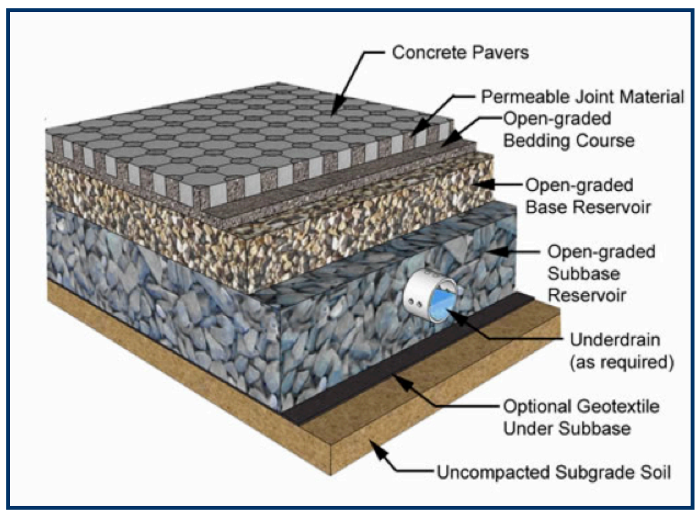

Fig. 3. Permeable Interlocking concrete pavers illustration.
http://www.cement.org/homes/ch_newsletter2009-11&12.asp

Both porous asphalt and pervious concrete are modified versions of the standard material where void space is created within the material to allow water to percolate through the pavement. This void space is created by removing a large portion of the fine aggregate in the mix design. Permeable interlocking concrete pavers, while not porous themselves, contain joints filled with small uniformly graded aggregate which allows for the passage of water.

Other porous surfaces such as grass and gravel pavers are also available depending on the usage of the surface and vehicle loading. These systems consist of rigid grids which are then filled with gravel or turfgrass.

Benefits of Porous Pavement

There are numerous benefits associated with the use of porous pavement.

1. VOLUME REDUCTION & FLOOD CONTROL: Because water flows through porous pavement, the volume of runoff generated during a storm event is significantly decreased or eliminated altogether. This reduction in volume results in flood control and reduces the need for traditional stormwater infrastructure (piping, catch basins, stormwater ponds, curbing, etc.).
2. WATER QUALITY: Pollutants are captured during infiltration, reducing pollutant load to local waterways. Infiltrated runoff recharges groundwater supplies, improves flow in streams, and reduces the need for landscaping irrigation.
3. ROAD SAFETY AND DURABILITY**:** Porous pavement increases skid resistance and traction on wet surfaces while also reducing the spray from passing vehicles and decreasing noise. Since water infiltrates rather than pools, black ice does not form and less road salting is needed. Pavement lifespan also increases.
4. COMPLIANCE: Porous pavement is included as a structural control in the South Carolina DHEC Storm Water Management BMP Handbook. Because the use of porous pavement reduces the overall impervious area of site and therefore the volume of runoff, its application could qualify a site for stormwater utility credits (if they exist within the community) and help to meet site development standards.
5. HEAT ISLAND EFFECT MITIGATION**:** Heat islands are developed areas that are hotter than surrounding rural areas. Traditional paving materials, which become hotter than vegetated surfaces, contribute to the heat island effect. In applications of porous pavement, the amount of heat released at night is reduced due to the limited transfer of heat to the subsurface layers. Wet and dry pavement may behave differently, however. Porous pavement can also reduce the temperature of runoff which results in less thermal stress to aquatic life in the receiving waters.

Applications

Porous pavement can generally be substituted for traditional pavement provided that soil characteristics, slope, climate, depth to groundwater, and vehicle usage/loading are suitable. There should be a relatively deep water table or distance to bedrock from the bottom of the system. Underlying soils should be well-drained with a minimum infiltration rate of .3 inches per hour and slopes no greater than 5%. While 0.3 inches per hour is the minimum recommendation according to the South Carolina BMP Handbook, systems have been successfully designed for subgrades having lower infiltration rates. To compensate for the lower structural support capacity of clay soils, additional subbase depth is often required. The increased depth also provides additional storage volume to compensate for the lower infiltration rate of the clay subgrade. Underdrain usage can also help in low infiltration rate situations.

As a general rule, porous pavement should not be used in areas of frequent and/or heavy truck traffic. It is generally suitable for low-volume roadways, sidewalks, driveways, and parking lots.

Porous pavements require special considerations in the following situations:

- Within 4 feet of seasonally high water table
- Slopes greater than 5%
- Within 100 feet of a well
- <10 feet down gradient from building foundations and <100 feet up gradient
- Areas where wind erosion supplies significant deposits of sediment
- Drainage areas <15 acres
- Soil infiltration less than 0.3 inches per hour
- In close proximity to hazardous materials storage or transport areas

Cost Comparison

The material cost for pervious concrete or porous asphalt is approximately 20% more than its conventional counterpart. This only considers surface material and does not account for the aggregate base material or other materials that may be used. PICP have a similar cost to traditional pavers although the cost of the aggregate used for the bedding layer and to fill the joints will be greater than the cost of sand used in impermeable pavers. While the material itself may be more expensive, the overall cost of the project is typically offset by the decreased need for traditional stormwater infrastructure and reduction of irrigation demands in nearby landscaped areas. Maintenance costs vary on a case-by-case basis, but porous pavement maintenance costs are generally comparable or less than traditional pavement when other BMPs are included. For example, a project in the City of Olympia, Washington calculated the yearly maintenance of a traditional concrete sidewalk and associated BMPs to be $156,000 compared to $147,000 for pervious concrete (McFadden, 2005). Pavement lifespan is generally longer for porous pavement, which also results in cost savings. The lifespan of a northern parking lot is typically 15 years for traditional pavement while porous asphalt parking lots can have a lifespan in excess of 30 years due to reduced freeze/thaw stress (Gunderson, 2008).

Maintenance Needs

Porous pavement should be inspected and vacuumed or washed at least twice a year as preventative maintenance. Routine preventative maintenance will be more effective than corrective maintenance and ensure optimal performance of the system. It is essential to prevent opportunities for sediment to make its way onto porous pavement as this can clog the surface.

If used in an area receiving snowfall or ice, it is important to avoid the use of sand and sand/salt mixes, which can cause clogging. It should also be noted that larger quantities of deicers might be needed on porous pavement, as the materials will drain through the pavement rather than staying at the surface. Care should also be used when plowing porous surfaces. More information about porous pavement applications in cold climates can be found at the University of New Hampshire Stormwater Center at http://www.unh.edu/unhsc/.

Other Considerations

Porous pavement offers structural, economic, water quality, and storage benefits. In order to ensure a functioning porous system, it is necessary to have accurate design, proper construction/installation, and the development and implementation of maintenance plans. It is recommended that signs be installed where porous pavement is used to raise awareness and reduce the potential for improper maintenance. When considering the use of porous pavements, it is recommended that you seek contractors experienced with the product, preferably those with industry certification.

References

Gunderson, J. (2008, September). Pervious Pavements: New Findings About Their Functionality and Performance in Cold Climates. *Stormwater*. Retrieved from http://stormh20.com/SW/Articles/Pervious_Pavements_1071.aspx.

McFadden, P.E., M. (2005) Memo to Andy Haub. City of Olympia. Olympia, WA. 11 February 2005. http://olympiawa.gov/~/media/Files/PublicWorks/Water-Resources/Traditional_vs_Pervious_Concrete_Sidewalks_Memo.ashx

South Carolina DHEC. (2005). *Storm Water Management BMP Handbook*. Retrieved from https://www.scdhec.gov/environment/water/swater/docs/BMP-handbook.pdf

Source of Significant Contribution

United States Environmental Protection Agency. (1999) *Storm water technology fact sheet porous pavement*

Additional Resources:

EPA BMP Fact Sheets:
Permeable Interlocking Concrete Pavers:
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=136&minmeasure=5

Pervious Concrete Pavement:
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=137&minmeasure=5

Porous Asphalt Pavement:
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=135&minmeasure=5

NC State Stormwater:
http://www.bae.ncsu.edu/stormwater/

University of New Hampshire Stormwater Center:
http://www.unh.edu/unhsc/

Content reviewed by Brad Putman, Ph.D., Associate Professor of Civil Engineering, Clemson University and Katherine Snyder, Ph.D., South Carolina Watershed Coordinator, US Environmental Protection Agency, Region 4.